February 12, 2004

Dan Landon
Executive Director
NCTC
101 Providence Mine Road
Suite 102
Nevada City, CA 95959

RE: OPERATIONS TRAFFIC STUDY FOR SR 20/49 FRONTAGE ROAD

Dear Dan:

PRISM Engineering has completed our assessment of traffic conditions along the SR 20/49 frontage road system. There is the potential to modify the local street and freeway ramp system to increase capacity and improve levels of service. This letter report summarizes our field data and our findings concerning potential mitigations to the street system.

Sincerely,
PRISM Engineering

Grant P. Johnson, PE, PTOE
Principal

Origin / Destination Surveys

One of the purposes of this work was to determine the vehicles per minute (vpm) flow rate of traffic from the Idaho Maryland Intersection to the freeway on-ramp[1] and to compare that with the expected flow rate from a roundabout. The hourly average flow rate to the onramp from a roundabout with a single lane approach on Idaho Maryland will be about the same as the existing stop sign controlled intersection, but the average flow from a roundabout with a two-lane approach on Idaho Maryland will be in the 14-16 vpm range.

We noted the potential for the weave to become a problem in the next few years. Caltrans has suggested that if the Idaho Maryland On-ramp freeway weave were eliminated, it would be possible to make any improvement at the Idaho Maryland/East Main Intersection.

PRISM Engineering conducted a license plate survey to determine existing traffic patterns between the Idaho Maryland, Auburn Street and Empire Street ramps. License plate data was collected for each vehicle at the following consecutive freeway ramps:

1. Idaho Maryland Road SR 20/49 WB onramp
2. Auburn Street SR 20/49 WB onramp
3. Empire Street SR 20/49 WB offramp

The last three numbers of each license plate were written for each vehicle entering the respective ramp. The data was organized into five-minute intervals during the peak hour time period (4:15 to 5:15 pm). This data was then transcribed into a computer spreadsheet, and saved as a text file for post-processing in a computer program written by PRISM Engineering that found license plate matches between the three ramps. The summary of origin destination data is given in Table 1, and relates to traffic patterns during the pm peak hour time period.

A total of 138 vehicles were “tracked” via license plate survey from the Auburn Street on-ramp to the Empire Street off-ramp. Since 69 of these vehicles came from the Idaho Maryland on-ramp, it can be deduced that the remaining 69 vehicles came from the downtown area as they entered the Auburn Street on-ramp, and continued on to the Empire Street off-ramp. In

[1] (which according to the data is approximately 12-13 vpm)

row two of the table, it means that 160 of the 631 vehicles that entered the freeway at the Idaho Maryland on-ramp got off at the Empire Street off-ramp.

Table 1
Origin Destination Data Summary

Origin Location	Destination 1 Bennett Street Off-ramp (vph)	Destination 2 Auburn Street On-ramp (vph)	Destination 3 Empire Street Off-ramp (vph)
Idaho Maryland On-ramp via Frontage Road	113	69	69
Idaho Maryland On-ramp via SR 20/49 Freeway	N/A	N/A	160
Auburn Street On-ramp at Colfax Triangle	N/A	N/A	138

Source: PRISM Engineering

Video Traffic Counts

Digital video cameras were set up at the same three locations to capture weaving traffic patterns, peak hour factors, traffic flows, and speeds. This video footage was entered into a computer and observed to determine traffic volumes and traffic conditions at the weave sections of the freeway, as well as at the Colfax/Auburn/Neal Street triangle of intersections. From the video it was apparent that there is a potential safety and capacity issue at the Idaho Maryland on-ramp SR 20/49 weave with the Bennett Street off-ramp traffic. In addition, the Colfax/Auburn/Neal Street triangle set of intersections shows a busy pattern of traffic and inefficiencies built into the existing design.

The video traffic counts were taken on Wednesday January 14, 2004, and post-processed by electronic counter board to ensure accuracy. It was determined by inspection that the video traffic counts only slightly varied from the Year 2002 Caltrans counts taken for the Dorsey Drive Interchange Project (EA 412400). The PRISM Engineering video counts were slightly higher in some cases, and slightly lower at other locations. The variance was anywhere from a +/-1% difference to a +/-15% difference, which is typical for traffic counts from day to day. This indicates that there has not

been an appreciable difference in traffic volumes during the last year. The new traffic count data is summarized in the appendix.

The traffic count data was entered into the Synchro-Pro and Sim-Traffic micro-simulation software to examine traffic flows and patterns during peak hour demands. We utilized these software programs loaded with existing and future traffic volumes to determine the impacts that alternative traffic patterns would have on the system.

Freeway Weave Analyses

Freeway weaves were examined and analyzed on the SR 20/49 freeway from the Idaho Maryland Road on-ramp to the Empire Street off-ramp (a total of two Type A[2] weave sections). The HCM 2000 methodology found in Chapter 24 was used to analyze the two weave sections. The percent trucks on the Golden Center Freeway is approximately 7% in the study area. The grade of the freeway between Idaho Maryland Road and Empire Street is flat to rolling hills. Rolling hills was used in the calculations to be more conservative. The assumed free-flow speed used was 65 mph. These factors coupled with the existing peak hour volumes were used to calculate a level of service of LOS D for the Idaho Maryland/Bennett Street ramp weave, and LOS C for the Auburn/Empire Street weave. Table 2 shows the specific passenger car equivalent volumes (after grade and percent trucks are accounted for) and the corresponding levels of service for each ramp weave analyzed in the existing Year 2004 condition. Table 3 shows the Year 2027 condition.

The Idaho Maryland onramp will go to LOS E conditions when an increase of 7% in the existing traffic volume takes place. Using the NCTC traffic model as a guide for growth rates, this will take place in 3 to 4 years, or around the Year 2007 LOS E conditions will exist on the ramp weave. LOS F conditions, or total breakdown is projected to take place with a 23% increase. The freeway mainline volume is projected (by the model) to increase 23% by the Year 2016. These projections indicate that an improvement will be needed in the near future.

Table 3 shows the conditions that are projected for the Idaho Maryland on-ramp – Bennett Street off-ramp weave section by the Year 2027.

[2] A Type A freeway weave is where traffic has to only change one lane to make the weave. This is typified by a two lane freeway section with an adjacent auxiliary lane, or a total of three lanes in the weave section being analyzed. The auxiliary lane is an on-ramp which extends to become the off-ramp .

Table 2
Freeway Weave Analysis Summary, Year 2004

Bennett Weave Area Level of Service (LOS)	SR 20/49 Mainline Traffic (vph)	Mainline to Bennett (vph)	Idaho Maryland to Mainline (vph)	Idaho Maryland to Bennett (vph)
D	1,210 increased* to **1,573**	420 increased* to **526**	631 increased* to **820**	113 increased* to **147**
Empire Weave Area Level of Service (LOS)	**SR 20/49 Mainline Traffic (vph)**	**Mainline to Empire (vph)**	**Auburn to Mainline (vph)**	**Auburn to Empire (vph)**
C	1,057 increased* to **1,374**	702 increased* to **913**	362 increased* to **471**	138 increased* to **179**

**all trucks and cars converted (increased) to passenger car equivalent.*
Source: PRISM Engineering

Table 3
Freeway Weave Analysis Summary, Year 2027

Bennett Weave Area Level of Service (LOS)	SR 20/49 Mainline Traffic (vph)	Mainline to Bennett (vph)	Idaho Maryland to Mainline (vph)	Idaho Maryland to Bennett (vph)
F	1,706 increased* to **2,218**	592 increased* to **770**	890 increased* to **1,157**	159 increased* to **207**
Empire Weave Area Level of Service (LOS)	**SR 20/49 Mainline Traffic (vph)**	**Mainline to Empire (vph)**	**Auburn to Mainline (vph)**	**Auburn to Empire (vph)**
D/E	1,442 increased* to **1,874**	957 increased* to **1,245**	494 increased* to **642**	188 increased* to **245**

**all trucks and cars converted (increased) to passenger car equivalent.*
Source: PRISM Engineering

Alternatives Analysis

In recognition of the "weave" problem Caltrans has done preliminary investigation of various improvement concepts:

- Build a “flyover” bridge from the East Main Street intersection to connect to the Gold Center freeway, and build an additional auxiliary lane on the Golden Center freeway to receive the fly-over ramp traffic (this would require additional bridge expansion on the freeway to accommodate the new lane). Cost is estimated to be prohibitive.

- Force Idaho Maryland onramp traffic to use the Bennett Street offramp and the existing frontage road system to travel to Auburn Street onramp to gain access to the freeway. Cost is minimal in comparison.

This report focused on the SR 20/49 frontage road system to determine if the available capacity could be utilized as part of a "low cost" solution to the weave problem. The freeway ramp weaves were also re-analyzed to determine if the shift in traffic flows would adversely affect the freeway and ramp operations.

It was determined that the change in traffic patterns did not have a significant effect on the operations of the freeway. LOS C conditions would still exist at the Auburn/Empire ramp weave in the existing condition. In the shifting of Idaho Maryland traffic volumes to the frontage road system, there is a reduction in over 800 vehicles to the mainline freeway just before the Auburn/Empire ramp weave area.

The emphasis of the analysis and associated mitigations focused on the frontage road system, and more especially at the Colfax/Auburn/Neat Street triangle of intersections. This triad of intersections is one of Grass Valley's highest accident locations, and any increase in traffic to the existing street layout will not be acceptable. See Figure 1 for details of the existing road system under study, and the corresponding traffic volumes and levels of service.

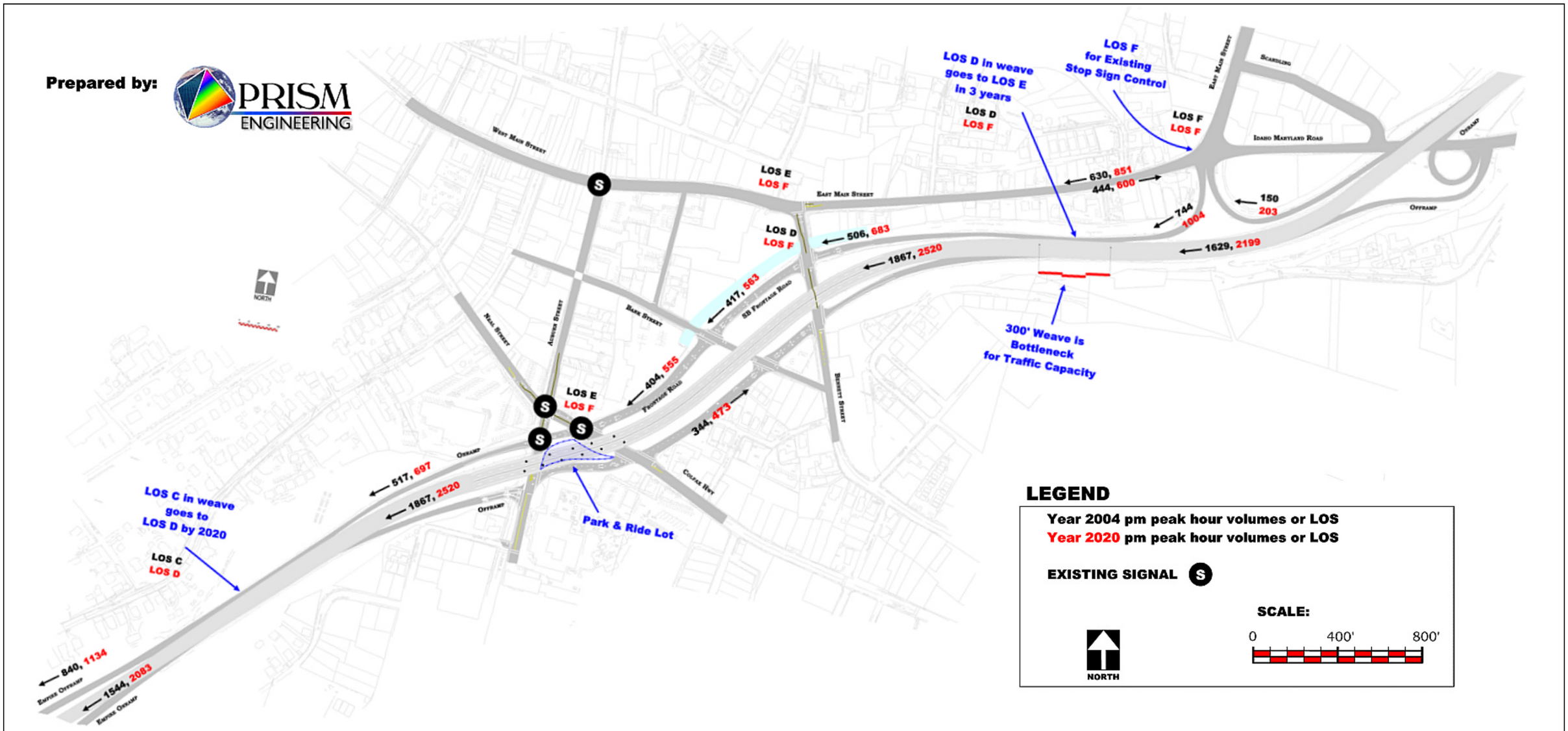


Figure 1 Existing Conditions for Frontage Road System

PRISM Engineering developed three different alternatives to the existing condition to address the geometry and capacity issues associated with this area. These alternatives include:

1. Realign many of the local streets to meet into one larger intersection, leaving the frontage road alignment in place so that traffic from the Idaho Maryland ramp can have a higher efficiency in getting onto the freeway. This can be done without interference to the freeway bridge piers, and a single signal would control the one new intersection. A side benefit is expanding the existing park and ride area by eliminating one lane of the frontage road on the east side. See Figure 2 for details of this concept.
2. Completely modify the internal road system to convert it to a single modern roundabout. This large roundabout would have high capacity and be able to handle the increase in traffic, and can be physically accommodated between the existing freeway bridge piers. This concept differs from previous concepts developed for the area in that Auburn Street southbound traffic is forced to turn right at Neal Street. See Figure 3 for this concept.
3. Convert existing streets to one-way streets in the counter-clockwise direction, so that the triangle essentially becomes a one-way loop. See Figure 4 for details of this concept. Stop sign control would handle initial traffic control for the area.

Either one of these alternatives will provide immediate relief to existing traffic patterns through the triad of intersections because these changes will provide additional capacity. Only the first alternative will provide enough additional capacity to handle the shifting in Idaho Maryland on-ramp traffic, as well as future growth traffic. Therefore the best alternative from a traffic engineering standpoint of capacity and circulation is Alternative 1, with Alternative 2 coming in second, and Alternative 3 a distant third. Alternative 3 has clear sight distance , whereas the roundabout in Alternative 2 has sight distance challenges with the travel path through the freeway bridge support piers. Alternative 3 is more limited in capacity due to short storage lengths between the existing signalized intersections. The changing to one-way streets helps reduce turning conflicts and increase capacity, but it is still limited by storage distances. Figure 2A shows the overall improvement concept for Alternative 1, and Figure 2B shows an enlarged detail area.

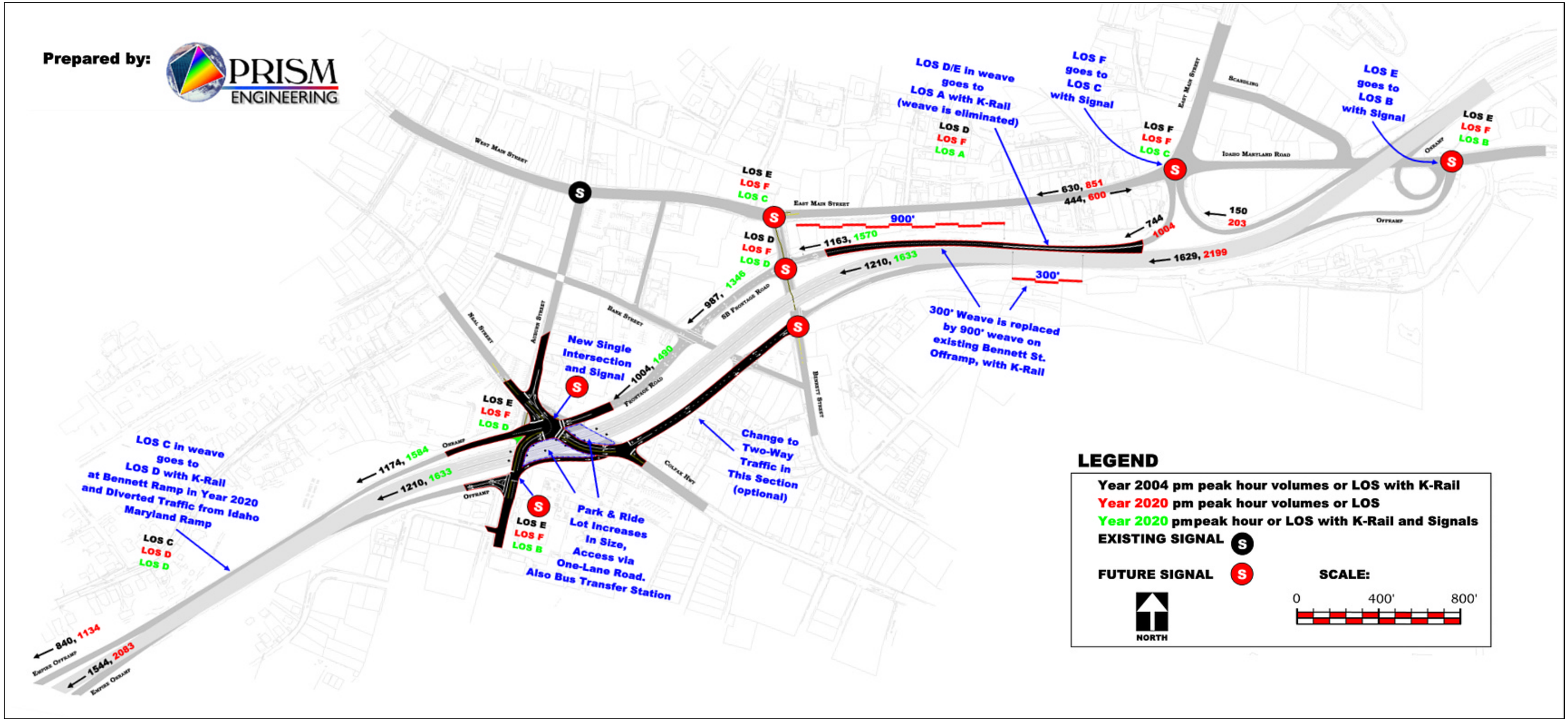


Figure 2A Alternative 1, Realigning of Streets into One Intersection

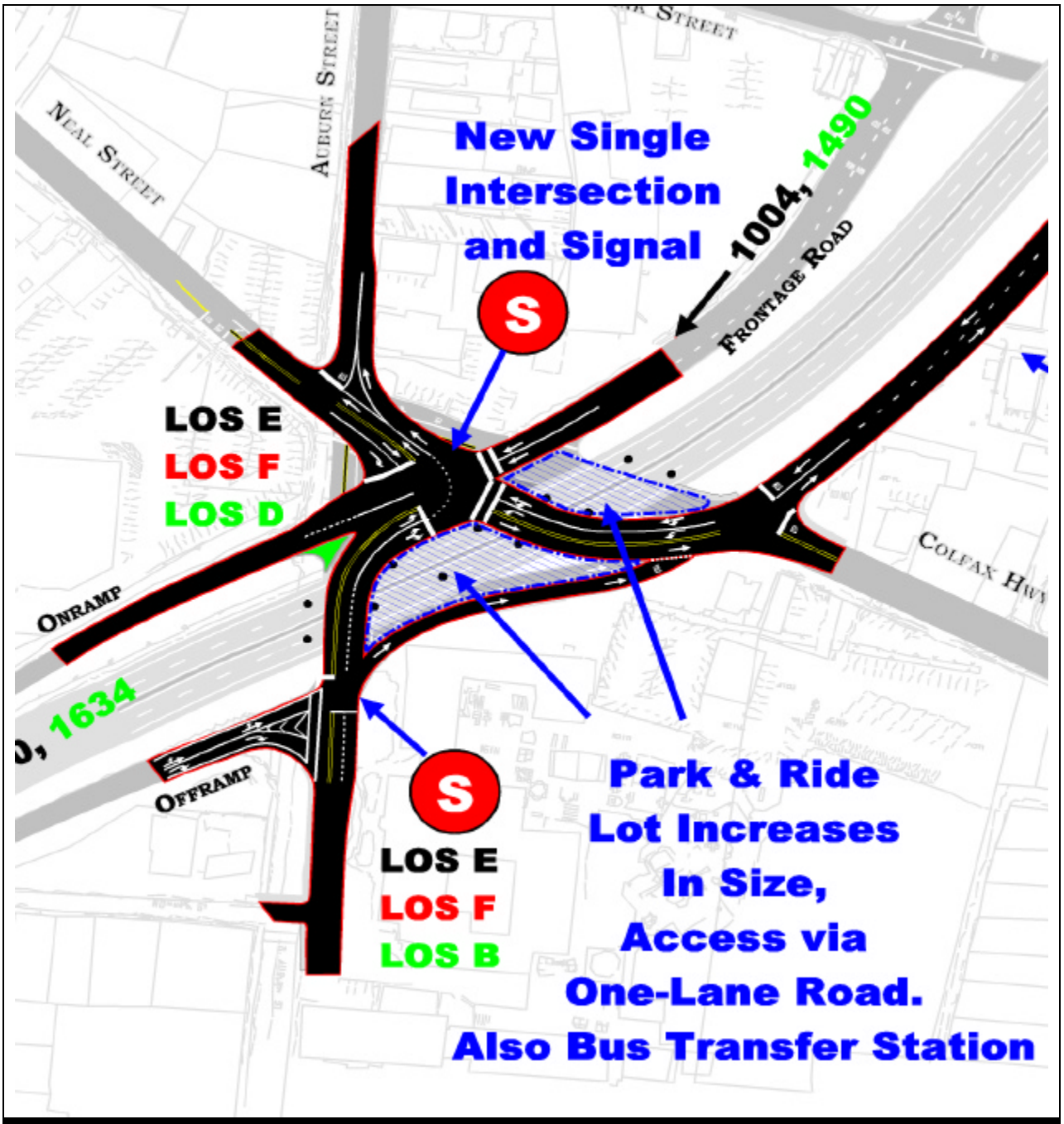


Figure 2B Alternative 1 Details

Signals are currently installed at Neal/Auburn, Colfax/Frontage, and Auburn/on-ramp intersections. This alternative eliminates four intersections, and channels all traffic into one intersection. All previous travel paths are supported.

Pros: Has increased efficiency for traffic from off-ramp with new signal. Can move high volumes of traffic along frontage road to freeway with priority signal timing. A dual left turn lane into Auburn Street downtown moves traffic efficiently. Park and ride lot area would be increased in size through elimination of one lane of frontage road.
Cons: None apparent.

Roundabout Alternative 2

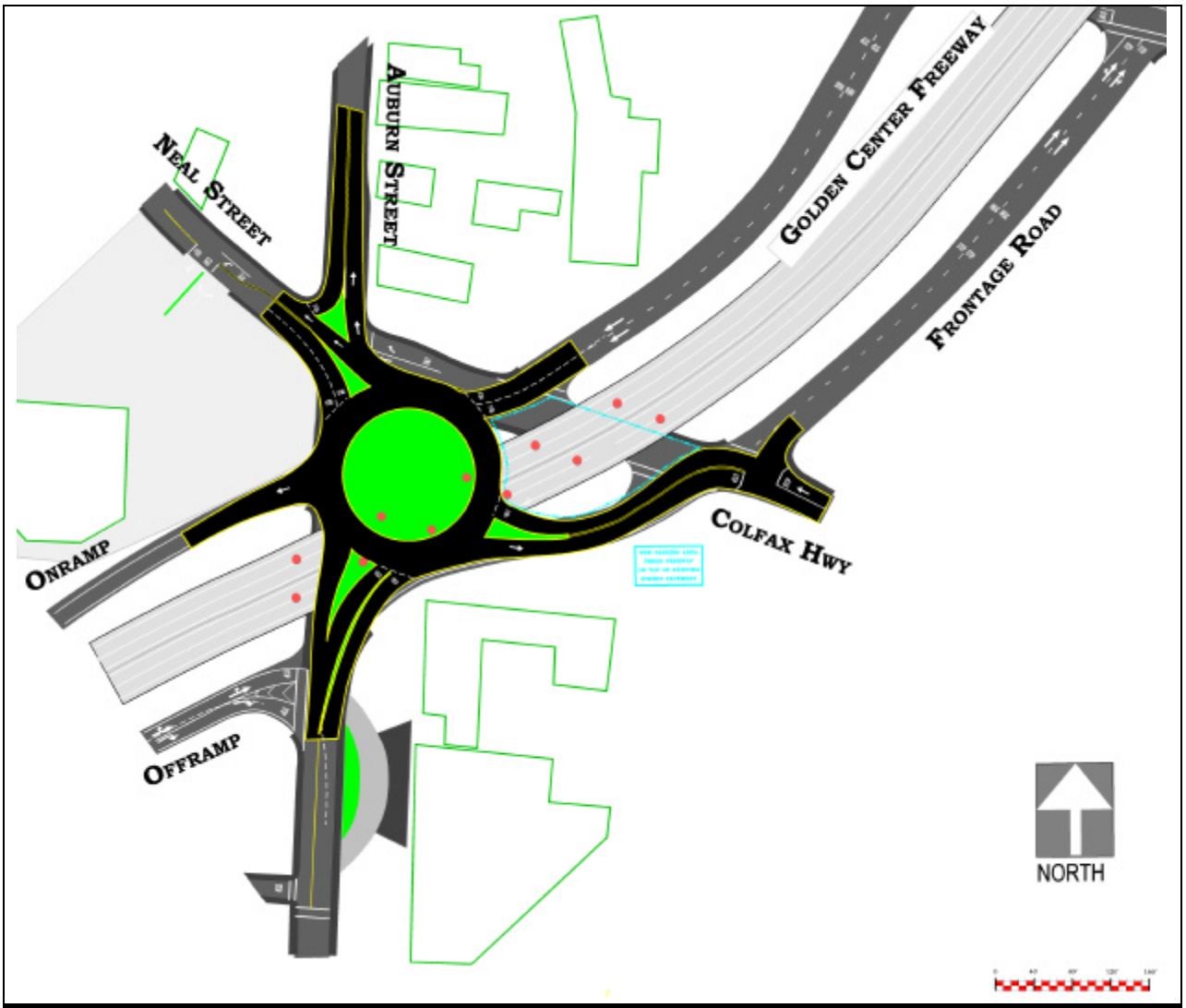


Figure 3 Construction of Roundabout to Replace Intersections

This mitigation concept shown in Figure 3 can help to eliminate many of the existing capacity constraints in the downtown area, and provide a gateway

to and from the freeway system for existing conditions. However, it is limited in capacity for longer term solutions, or to provide additional capacity needed for say, sending more traffic down the frontage road to eliminate the hazardous weave on SR 20/49 at the Idaho Maryland/Bennett Street ramps.

Pros: Traffic entering the roundabout from the offramp only have to cross one lane of traffic, helping keep ramp traffic moving.
Cons: Park and ride lot size is reduced. Sight distance is somewhat limited due to freeway bridge pier proximity to roundabout path, however, speeds are slow. Roundabout will fail on frontage road entrance due to high volumes with shifting of Idaho Maryland onramp traffic.

One-Way Couplet Concept

This alternative shown in Figure 4 helps to eliminate many of the turning conflicts and associated lane storage needs, but continues to use the existing three traffic signals (modified to work only with the one-way movements). It is limited in capacity to handle any future traffic volumes, or to handle the additional proposed traffic flows on the frontage road (traffic diverted from the Idaho Maryland onramp).

Pros: It will work better than the existing condition where two-way movements are allowed at nearly every intersection. It will reduce accidents by virtue of eliminating many conflicts.
Cons: It falls short of mitigating an inferior design of closely spaced intersections (which contribute to accidents). Has limited capacity compared to other concepts. It will fail with the additional proposed frontage road traffic volumes.

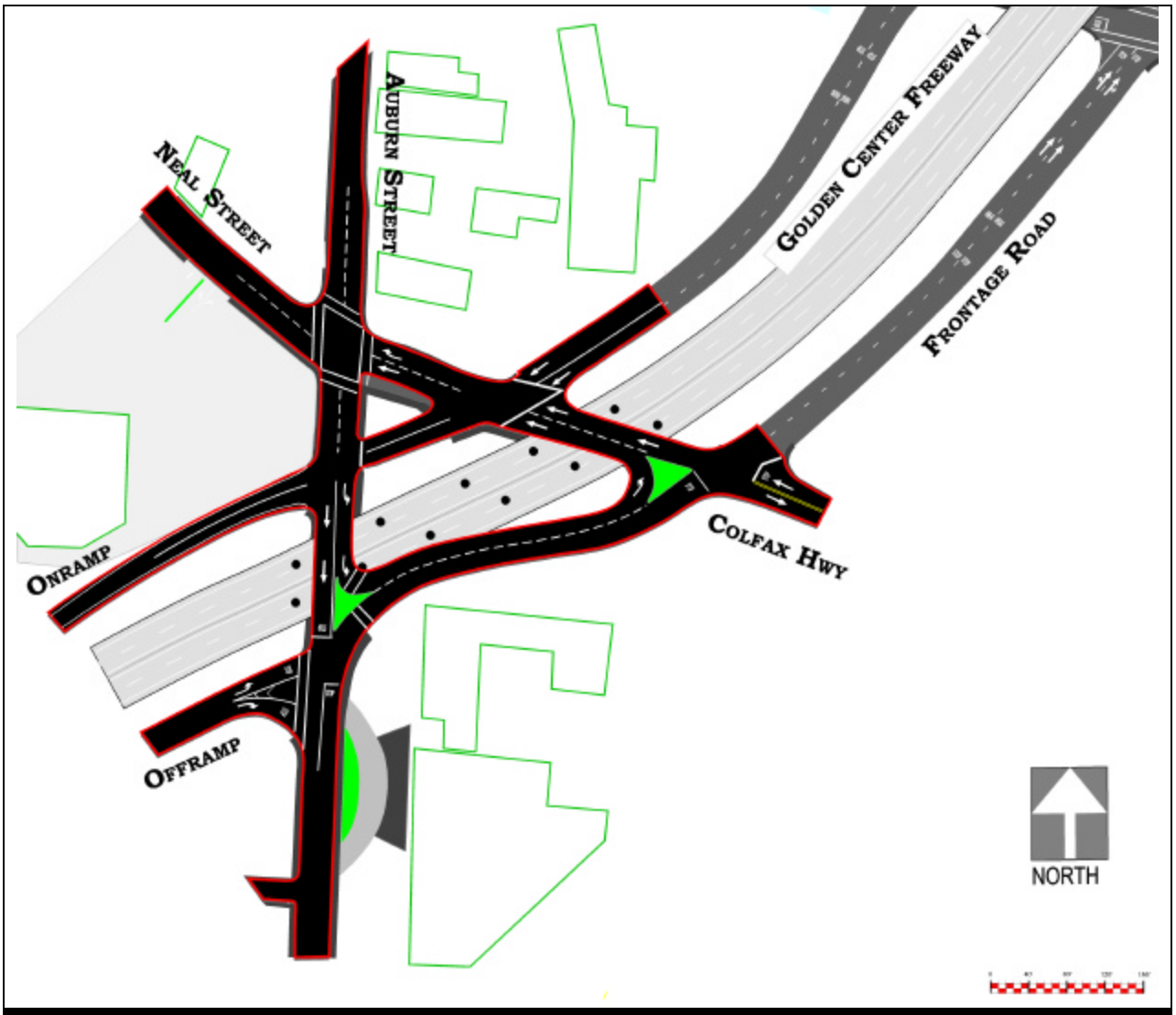


Figure 4 Convert Existing Streets to One-Way Loop

Conclusions

This study has identified the fact that the Idaho Maryland weave with the Bennett Street offramp traffic is at LOS D and will go to LOS E in approximately three years. This is an unacceptable traffic condition on an under-designed 300 foot weave section that will negatively affect the operations of the adjacent intersection of Idaho Maryland Road at East Main Street. This weave was identified in our current micro-simulation efforts (an expansion of the scope of work performed for the Idaho Maryland/East Main Street intersection roundabout studies).

This study utilized an origin-destination study to analyze the effectiveness of rerouting traffic along the frontage road system. It was determined that there is ample capacity in the frontage road system to handle the additional traffic, and that significant improvements would need to be made at the South Auburn/Colfax Avenue/Neal Street intersections. Three potential intersection improvement alternatives were analyzed and there is at least one alternative that will effectively handle the traffic diverted from the Idaho Maryland on-ramp to the frontage road system.

The preferred alternative, is a single signalized intersection that will replace three closely spaced intersections. It will reduce existing traffic turning movement conflicts, and significantly increase capacity to the system by providing an efficient intersection and signal design at the new intersection. The signal can be timed so as to provide sufficient time for all vehicles to get through, and keep the majority of traffic moving efficiently (LOS D or better conditions).

Improvement of the South Auburn/Colfax Avenue intersection and eliminating the Idaho Maryland on-ramp weave problem will facilitate installation of signals at the Idaho Maryland/East Main intersection. Signal installation will be less costly and have fewer impacts on businesses adjacent to the intersection than the proposed roundabout.

If traffic for the Idaho Maryland on-ramp is diverted to the frontage road system, a signal will eventually be needed at the Bennett Street/SR 20/49 ramp intersection and should be coordinated with the signal being installed at the East Main Street/Bennett Street intersection. The three existing signals at the Colfax Highway/Frontage/Auburn/Neal intersections can be consolidated into one signal.

APPENDIX

Traffic Counts, January 14, 2004, *one hour summaries in 15 minute intervals from 4:20 pm to 5:20 pm*

Idaho Maryland Onramp

Merge	Stay On	
149	35	
150	30	
164	27	
168	21	total
631	**113**	**744**

SR 20 at Bennett

Stay on	Exit	
346	90	
252	100	
179	117	
433	113	total
1210	**420**	**1629**

Frontage at Colfax

WBL	WBT	WBR	NBL	NBT
7	61	27	26	38
9	56	32	33	36
8	60	21	34	38
7	72	44	28	36
31	**249**	**124**	**121**	**148**

Frontage at Auburn

WBL	WBT	NBL	NBT	SBR	SBT
19	61	6	85	51	51
22	70	4	77	53	48
29	69	7	81	48	43
37	61	7	105	62	31
107	**261**	**24**	**348**	**214**	**173**

Auburn Onramp

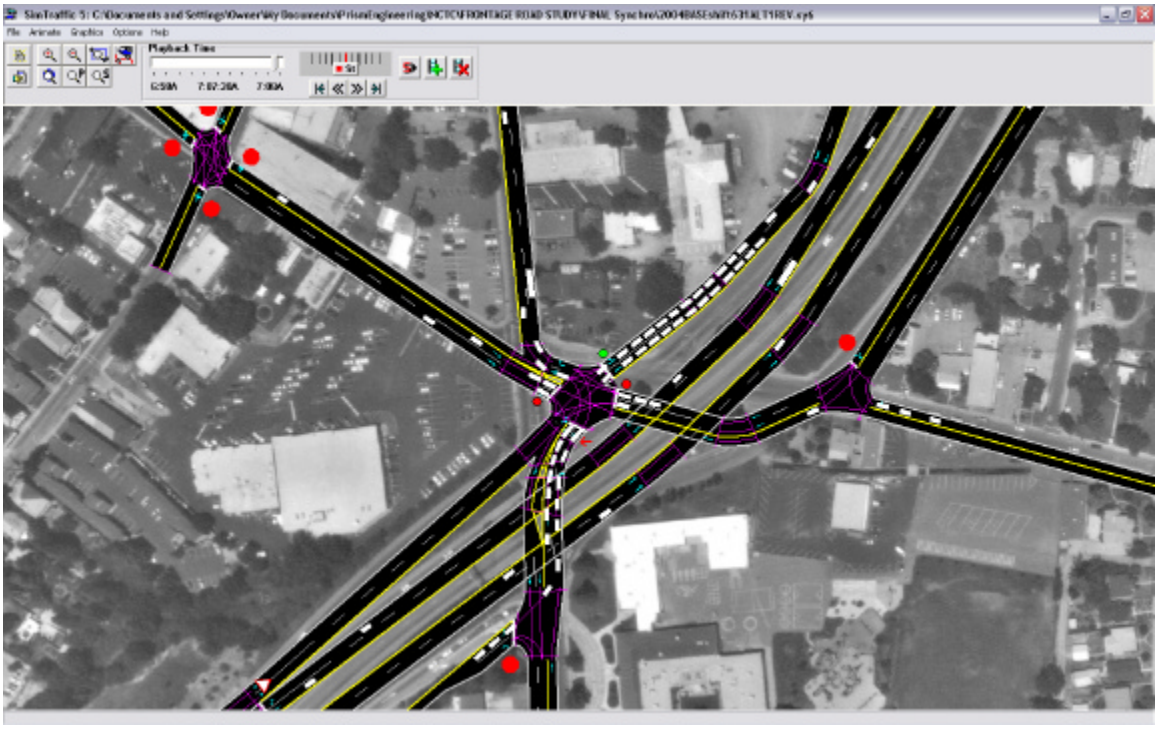
Merge	Stay On	
86	31	
94	34	
96	42	
86	31	total
362	**138**	**500**

Empire Offramp

Merge	Stay On	
143	261	
188	281	
159	252	
212	263	total
702	**1057**	**1759**

Source: PRISM Engineering

Synchro Micro-Simulation Model "Snapshots" of PM conditions



Preferred Alternative, Year 2004 traffic with Idaho Maryland on-ramp traffic diverted. Traffic does not back up beyond adjacent intersections.